

Experimental and Non-Experimental Research

Understanding causal, comparative, descriptive, correlational, and observational research designs

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Experimental

Manipulate variables
and compare groups

Non-Experimental

Observe variables
as they naturally
occur

Lecture Overview

This lecture explains when, why, and how researchers use experimental and non-experimental designs.

Foundations

Variables, causal logic, comparison groups, control, validity, and measurement.

Experimental Designs

True, quasi, and pre-experimental approaches with practical examples.

Non-Experimental Designs

Descriptive, correlational, comparative, observational, and case study designs.

Application

Research scenario, ethical issues, classroom activities, questions, and key takeaways.

Learning Objectives

Students will be able to:

- 1** Define experimental and non-experimental research using accurate terminology.
- 2** Distinguish manipulation, control, random assignment, and observation.
- 3** Compare true, quasi, pre-experimental, descriptive, correlational, and comparative designs.
- 4** Select an appropriate design for a given research question.
- 5** Identify strengths, limitations, threats to validity, and ethical issues.
- 6** Apply the designs to realistic studies in multiple academic disciplines.

Introduction: Why Design Choice Matters

Research design is the logical plan that connects research questions, evidence, analysis, and interpretation. A strong design helps researchers make credible claims while recognizing the limits of the evidence.



Experimental research asks

What happens when the researcher changes an independent variable under controlled conditions?

Non-experimental research asks

What patterns, relationships, differences, or meanings can be observed without manipulating variables?

Key Definitions

Term	Student-friendly meaning
Independent variable	The factor thought to influence an outcome; manipulated in experiments.
Dependent variable	The outcome measured by the researcher.
Control group	A comparison group that does not receive the treatment or receives standard conditions.
Random assignment	Participants are allocated to conditions by chance to reduce selection bias.
Confounding variable	A third factor that may explain the relationship between variables.
Validity	The degree to which a study supports accurate conclusions.

Background and Context

The distinction between experimental and non-experimental research developed from the need to understand causality, prediction, description, and explanation across the sciences.

Classical experiments

Controlled trials and laboratory studies emphasized manipulation and comparison.

Social research

Researchers adapted designs for complex human settings where perfect control is difficult.

Modern practice

Researchers combine designs, use transparent reporting, and evaluate validity carefully.

Design is not a decoration added to research; it is the structure that makes evidence meaningful.

Main Concepts: Variables and Causal Logic

Variable

A characteristic that can vary across people, groups, settings, or time.

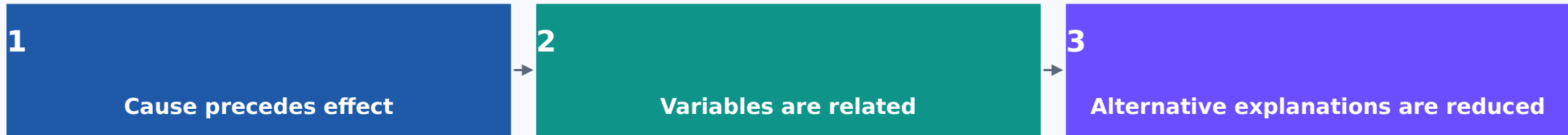
Causal claim

A statement that one variable produces a change in another variable.

Association

A relationship between variables that does not by itself prove causation.

THREE COMMON CONDITIONS FOR CAUSAL INFERENCE



Experiments are designed to support these conditions more directly. Non-experimental studies can suggest patterns and explanations, but they require cautious interpretation.

Main Concepts: Control, Comparison, and Validity

Concept	Why it matters	Typical question
Control	Reduces the influence of unwanted variables.	Were conditions kept consistent?
Comparison	Allows researchers to judge whether outcomes differ across groups or time.	Compared with what?
Internal validity	Supports confidence that the observed effect is due to the treatment.	Is the causal explanation credible?
External validity	Concerns whether results may apply beyond the study setting.	Can findings generalize?
Measurement validity	Ensures the study measures what it claims to measure.	Are the measures appropriate?

No design is perfect. Researchers select a design that best balances control, realism, ethics, feasibility, and the research question.

Experimental Research

Experimental research tests cause-and-effect relationships by manipulating an independent variable and measuring its effect on an outcome.



Example

A researcher randomly assigns students to two teaching methods and compares exam scores after four weeks.

Best used when

The researcher can ethically and practically control exposure to the intervention or condition.

Core Features of Experimental Research

Manipulation

The researcher actively introduces a treatment, intervention, or condition.

Control

Conditions are kept as similar as possible except for the independent variable.

Comparison

At least two groups, conditions, or time points are compared.

Random assignment

Used in true experiments to balance groups at the beginning.

Outcome measurement

The dependent variable is measured systematically after exposure.

Validity checks

Researchers examine threats such as history, maturation, and attrition.

True Experimental Designs

True experiments include manipulation, a comparison condition, and random assignment. Random assignment helps make groups similar before the intervention begins.

Design	Basic structure	Example use
Posttest-only control group	R → Treatment → Posttest; R → Control → Posttest	Testing a new training module.
Pretest-posttest control group	R → Pretest → Treatment → Posttest; R → Pretest → Control → Posttest	Comparing learning gains.
Solomon four-group	Combines groups with and without pretests.	Checking whether a pretest influences results.

Key reminder

Random assignment is different from random sampling. Sampling concerns who enters the study; assignment concerns which condition participants receive.

Quasi-Experimental Designs

Quasi-experiments study interventions or exposures using comparison strategies, but without full random assignment.

Nonequivalent groups

Compares existing groups, such as two schools or departments.

Interrupted time series

Examines repeated measures before and after an intervention.

Regression discontinuity

Assigns treatment based on a cutoff score or threshold.

Matched comparison

Creates comparable groups using matching variables.

Pre-Experimental Designs

Pre-experimental designs involve a treatment or observation but lack important control features. They can be useful for pilot testing, feasibility assessment, or early exploration.

Design	Structure	Major limitation
One-shot case study	Treatment → Observation	No pretest and no comparison group.
One-group pretest-posttest	Pretest → Treatment → Posttest	Changes may be due to history, maturation, or testing effects.
Static-group comparison	Treatment group vs. existing comparison group	Groups may differ before the treatment.

Instructor note

Treat pre-experimental findings as preliminary unless stronger evidence is available.

Step-by-Step Experimental Research Process



Plan control

Identify potential confounders and decide how to reduce them.

Standardize procedures

Use consistent instructions, timing, instruments, and data collection conditions.

Document protocol

Keep a transparent record of the design, intervention, measures, and analysis plan.

Interpret cautiously

Connect statistical results with design quality and validity threats.

Non-Experimental Research

Non-experimental research studies variables as they naturally occur without manipulating the independent variable.

Researchers use non-experimental designs when they want to describe a phenomenon, examine relationships, compare existing groups, study natural behavior, or explore complex real-world situations.

Example

A researcher examines whether study habits are associated with GPA using survey data from university students.

Best used when

Manipulation is impossible, unethical, impractical, or not required by the research question.

Types of Non-Experimental Research



Type	Main purpose	Typical data
Descriptive	Describe characteristics, frequencies, opinions, or conditions.	Surveys, records, observations
Correlational	Examine associations between variables.	Scores, scales, measurements
Comparative / ex post facto	Compare pre-existing groups or conditions.	Group data, records, outcomes
Observational	Observe behavior in natural or structured settings.	Field notes, checklists, video coding
Case study	Study one case, program, organization, or community deeply.	Interviews, documents, observations

Descriptive Research

Purpose

To describe characteristics, trends, opinions, behaviors, conditions, or needs in a population or setting.

Common methods

Surveys, structured observations, document analysis, administrative records, and needs assessments.

EXAMPLE RESEARCH QUESTIONS

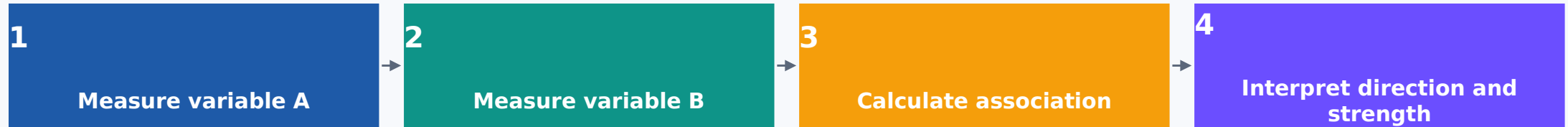
- What percentage of students use online library databases?
- How do employees describe workplace communication practices?
- What are the most common barriers to patient follow-up visits?

Main caution

Descriptive results summarize what is observed. They do not prove why the pattern exists.

Correlational Research

Correlational research examines whether changes in one variable are associated with changes in another variable. It can support prediction but does not establish causation by itself.



Positive relationship

Higher values of one variable tend to occur with higher values of another.

Negative relationship

Higher values of one variable tend to occur with lower values of another.

No clear relationship

Variables do not show a systematic pattern in the data.

Comparative and Ex Post Facto Research

Comparative non-experimental research examines differences between groups that already exist before the study begins.

Examples of existing groups

Gender, age group, school type, job role, diagnosis category, prior training experience, or exposure history.

Typical analyses

Group comparisons such as t-tests, ANOVA, chi-square tests, or regression with group indicators.

Main caution

Because groups are not randomly assigned, differences may reflect selection effects or other confounders.

Observational and Case Study Designs

Naturalistic observation

Researchers observe behavior in real-world settings with minimal interference.

Structured observation

Researchers use defined categories or checklists to observe specific behaviors.

Case study

Researchers examine one case deeply using multiple sources of evidence.

USEFUL WHEN RESEARCHERS NEED CONTEXTUAL UNDERSTANDING

- Classroom interaction patterns during group learning.
- Decision-making processes inside one organization.
- Patient experiences in a health program.
- Technology adoption in a specific community.

Quality depends on

Clear observation protocols, careful documentation, reflexivity, triangulation, and transparent interpretation.

Step-by-Step Non-Experimental Research Process



Operationalize variables

Convert broad concepts into measurable indicators or observable categories.

Reduce bias

Use reliable instruments, sampling logic, clear coding, and transparent procedures.

Analyze relationships

Describe patterns, compare groups, model associations, or develop themes.

Avoid overclaiming

Do not state causal conclusions unless design and evidence support them.

Practical Examples Across Disciplines

Discipline	Experimental example	Non-experimental example
Social sciences	Test whether a civic education workshop changes political knowledge.	Survey community trust in local institutions.
Business	A/B test two product-page layouts for conversion.	Examine the association between job satisfaction and turnover intention.
Education	Compare two randomly assigned reading interventions.	Describe teacher perceptions of online assessment.
Health sciences	Evaluate a new reminder intervention for medication adherence.	Compare recovery outcomes among existing patient groups.
Psychology	Test whether sleep restriction affects attention scores.	Correlate stress level with self-reported well-being.
Information technology	Experiment with interface design and task-completion time.	Observe how users adopt a new learning management system.

Detailed Research Scenario

Research topic

Effect of active-learning quizzes on undergraduate statistics performance.

Research problem

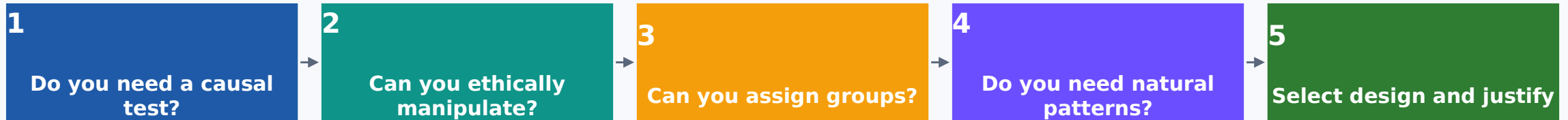
Students often struggle to apply statistical concepts in problem-solving tasks.

Element	Example decision
Research question	Do weekly active-learning quizzes improve statistics test scores compared with standard review?
Participants	Two sections of an undergraduate statistics course.
Design option	Quasi-experimental nonequivalent groups if sections cannot be randomly assigned.
Data collection	Pretest, weekly quiz participation data, posttest, and attendance records.
Data analysis	Compare posttest scores while considering pretest scores and attendance.
Expected interpretation	Higher adjusted posttest scores in the quiz section would suggest a promising effect, but selection and instructor differences must be considered.

Comparison Table

Criterion	Experimental research	Non-experimental research
Researcher role	Manipulates at least one independent variable.	Observes variables as they naturally occur.
Main purpose	Test causal effects under controlled conditions.	Describe, compare, predict, or explore natural patterns.
Random assignment	Often present in true experiments.	Not used to assign exposure or conditions.
Control over variables	Higher control; procedures can be standardized.	Lower control; relies on design, measurement, and analysis strategies.
Typical claim	Can support stronger causal conclusions when well designed.	Can support descriptive, relational, and cautious explanatory claims.
Common examples	RCT, laboratory experiment, field experiment, quasi-experiment.	Survey, correlation, ex post facto, observation, case study.

Choosing the Right Design



Choose experimental when...

The goal is to test an intervention, manipulation is ethical, conditions can be controlled, and comparison is feasible.

Choose non-experimental when...

The goal is description, prediction, comparison of existing groups, observation of natural behavior, or in-depth understanding.

Justification matters

A research proposal should explain why the chosen design is the best fit for the question, context, ethics, resources, and evidence needed.

Advantages and Applications

Experimental research strengths

Strongest design family for testing causal effects; allows control, comparison, replication, and clear intervention evaluation.

Non-experimental research strengths

Useful in natural settings; supports description, prediction, comparison, theory building, and ethically sensitive topics.

Use case	Best-fit approach
Testing whether a new method causes improvement	Experimental or quasi-experimental
Describing student attitudes toward online learning	Descriptive non-experimental
Predicting employee turnover intention	Correlational non-experimental
Studying experiences inside one school or hospital	Case study / observational
Evaluating a policy rolled out in one city before another	Quasi-experimental

Limitations and Challenges

Experiments: artificiality

Highly controlled settings may not fully reflect real-world behavior.

Experiments: feasibility

Randomization, control, time, cost, and participant recruitment may be difficult.

Experiments: ethics

Researchers cannot manipulate harmful, unfair, or sensitive exposures.

Non-experiments: causality

Observed relationships may be due to confounding or reverse causation.

Non-experiments: measurement

Self-reports, records, and observations may include bias or error.

Non-experiments: selection

Existing groups may differ before the study begins.

Common Mistakes and Best Practices

COMMON MISTAKES

- Calling a correlational study “experimental.”
- Claiming causation from cross-sectional survey data.
- Confusing random sampling with random assignment.
- Ignoring confounding variables or selection bias.
- Using weak measures without checking reliability or validity.

BEST PRACTICES

- Match the design to the research question.
- Define variables and procedures clearly.
- Use control or comparison strategies where possible.
- Report limitations honestly and avoid overclaiming.
- Use ethical, transparent, and reproducible methods.

Practical recommendation

Before collecting data, write one sentence that states the design, variables, participants, data source, and claim the study can reasonably support.

Ethical Considerations

Informed consent

Participants should understand the study purpose, procedures, risks, benefits, and voluntary nature of participation.

Risk and benefit

Experimental interventions must avoid unnecessary harm and should be justified by potential value.

Confidentiality

Protect identities and sensitive information in datasets, reports, and presentations.

Equity and justice

Avoid unfair selection of participants or unequal access to beneficial interventions.

Transparency

Report design, procedures, exclusions, and limitations honestly.

Bias reduction

Use fair measurement, careful analysis, and reflexive interpretation.

Activity: Classify the Research Design

Activity objective

Students will classify study descriptions and justify whether each is experimental, quasi-experimental, or non-experimental.

INSTRUCTIONS

- Form pairs or small groups.
- Read three short study descriptions provided by the instructor.
- Identify manipulation, comparison group, random assignment, and outcome measurement.
- Classify each design and explain the strongest claim it can support.

EXPECTED OUTCOME

Students should produce a one-paragraph justification for each classification. The best answers connect the design choice to the research question and validity concerns.

Instructor tip

Ask students to underline the words that reveal the design, such as “randomly assigned,” “surveyed,” “observed,” “compared existing groups,” or “implemented an intervention.”

Discussion Questions

- 1** When is it inappropriate or unethical to conduct an experiment?
- 2** Why does random assignment matter for causal inference?
- 3** Can non-experimental research ever contribute to causal understanding? How?
- 4** What validity threats are most common in educational or social research?
- 5** How can researchers reduce bias when they cannot manipulate variables?
- 6** Which design would you choose for your own research topic, and why?
- 7** How should researchers communicate limitations without weakening the study?
- 8** What is the difference between statistical significance and design credibility?

Knowledge Check and Answer Key

Question	Answer
1. Which feature defines experimental research?	Manipulation of an independent variable.
2. What does random assignment reduce?	Selection bias / pre-existing group differences.
3. Can correlation alone prove causation?	No. It can show association, not causation.
4. A survey describing student attitudes is what design?	Descriptive non-experimental.
5. Existing groups are compared after exposure has occurred. Design?	Comparative / ex post facto.
6. A study lacks random assignment but has an intervention. Design?	Quasi-experimental.
7. Name one ethical concern in experiments.	Risk, consent, fairness, confidentiality, or deception.
8. What should researchers avoid when reporting non-experimental findings?	Overclaiming causal conclusions.

Key Takeaways and Conclusion

Design follows the question

Choose the design that fits the claim you want to make.

Experiments test effects

Manipulation, comparison, and random assignment strengthen causal inference.

Non-experiments observe reality

They describe, compare, predict, and explore patterns without manipulation.

Validity matters

Control, measurement, sampling, and transparency shape credibility.

Ethics comes first

Research must protect participants and report findings honestly.

Conclusion: Experimental and non-experimental research are complementary tools. Strong researchers know what each design can show, what it cannot show, and how to communicate evidence responsibly.

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Thank You

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